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REVIEW ON ETHNOBOTANICAL PLANT SOURCES FOR MOSQUITO REPELLENCY USED BY TRIBES OF SOUTH INDIA

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ABSTRACT

Mosquitoes have become a serious threat to public health, transmitting several dangerous diseases, especially in tropical regions. There has been a large increase in the insecticide resistance of this vector, and it has become a global problem. Carbon dioxide, lactic acid and many other odors released from the body of warm blooded animals are the major attracts of mosquitoes. Numbers of mosquito repellents are available in the market, both synthetic and natural. Depending on the type of phytochemical present, plant sources, acts as either repellent or as an insecticide for killing the larvae of mosquitoes. The repellent activity of plant sources has been explored by human beings for many years, and man started using these plant sources in different forms like burning of leaves, hanging the plant at the entrance, external application of oil from plant extracts or growing the mosquito repellent plants around the houses. The use of plant sources as active mosquito repellents was even recorded in the writings of Greek and Roman Scholars. In many parts of rural India and other parts of the world, plant based mosquito repellents are still in use. For eg: Plant sources, which have repellent activity, are preferred as a good and safe source by people in rural areas of Europe and North America. The plant sources, which were reviewed and found to be used as mosquito repellents by tribes of South India are Cymbopogon flexuosus, Ocimum americanum, Tinospora cordifolia (Willd.), Miers Pentanema indicum (Linn.), Ling Bixa Orellana L, eucalyptus globules and, Cassia fistula. These were used as topical application of leaf juice (or) essential oils, extracted from leaves and plant parts. Whereas, Adhatoda Vasica Euphorbia Milli Des. Azardiracta Indica A.Juss, Dalbergia sissoo DC, Vitex negundo Linn, Artimesia vulgaris L, Clausena anisata, Adhatoda Vasica and Anacardium Occidentale in different forms.

KEYWORDS: Mosquito Repellents, Natural Sources, Tribes of South India & Medicinal Plants for Mosquito Repellency

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INTRODUCTION

There are over 3500 discovered mosquito species in the world; three most significant of these are the Aedes, Anopheles, and Culex. According to the World Health Organization (WHO), more than 1 million people die every year due to mosquito bites and the majority are due to malaria. A mosquito repellent can be in any form, i.e., it can be applied to the fabric, skin or any other surfaces in order to repel the host seeking mosquitoes. Many types of mosquito repellents are available in the market, both chemical and natural. For many years, the plants are considered as the valuable sources not only in preventing the mosquito bites, but also for many other medicinal values. Plants contain different types of bioactive chemicals which play an active role in preventing the attack of diverse kinds of insects.

Different parts of the plants have been used in the traditional medications in tribal communities for several years. Globally 20,000 medicinal plants have been identified by the World Health Organization (WHO), Out of which, India's contribution is 15–20%. In India, about 2000 drugs used are of plant origin. Tribes even depend on plant sources for mosquito repellent. Repellents play an important role in protecting man from different kinds of insects apart from mosquitoes. Burning of some herbs like *Artemisia* and *Azadirachta indica produces smoke* which has been used for the protection against mosquitoes and biting insects since ancient times. Planting of plant species like *Azadirachta indica*, *Annona squamosa*, *Artemisia vulgaris*, *Cymbopogon citratus*, *Lantana camara*, *Ocimum sanctum* and *Vitex peduncular* nearby the houses or settlement areas is another traditional method of controlling mosquito borne malaria, which is still in practice among many tribal communities in India. Still, in many rural areas of India, Polishing of house with extracts of different types of plants like Azadirachta, Artemisia, Lantana, Ocimum and Cymbopogon is routinely done in rural India to impel the mosquitoes and other flies.

Phytochemicals

Phytochemicals are the naturally occurring chemical compounds present in the plants, which mean Phyto-"plant" in Greek. The majority of the phytochemicals is accountable for colour and other phytochemicals are responsible in imparting the properties like, smell and flavour.

A unique biological activity is present in the phytochemicals derived from the plant sources. These phytochemicals derived from plant sources, acts as repellents, growth regulators and reproductive inhibitors.

Phytochemicals can be extracted from either whole plants or specific parts of the plant, depending on the activity of the derivatives. These bioactive chemicals occur in different parts of plants like roots, leaves, bark, flowers, stems, etc. Investigators have found that the effectiveness of chemicals derived from specific plant parts often varies with the mosquito species. Certain phytochemicals have photo-activated toxins that are reported effective against mosquitoes. Different phytochemicals in plants act or react with the mosquitoes in numerous ways for eg: few phytochemical acts as repellents, some acts as growth regulators, several acts as general toxicants to the life stages of mosquitoes, while few bioactive chemicals acts on the olfactory receptors.

Mode of Action of Phytochemicals in Insect Body

Plant extracts are generally known as the secondary metabolites that protect them from the herbivore. These metabolites are generally toxic, that are harmful for the insects and effect on the target molecules that are bio membranes, nucleic acid, cellular components and proteins, due to this, the insect physiology is disturbed that affect the nervous system such as synthesis of neurotransmitter, storage, release and activation of receptors. These phytochemicals act on the mosquito neurosystem in one or the other ways, like few inhibits the cellular respiration and potassium-sodium exchange. Few phytochemicals cause a nerve impulse, which blocks the nerve transmission in mosquitoes and insects.

Tribes of India

Plants/Herbs have been used by the tribal dwellings in remote places for many years, in meeting their lively hood and health care needs. These sources have been used by them in treating different kinds of diseases since time immemorial. Since there is increased interest in herbal products these days, even in modern or urban people, there is immense scope for research in validation of traditional claims for development of new drugs or medicines.

Review on Mosquito Repellent Plant Sources Used by Tribes of South India

Here is the list of plant species used for generations by various tribes throughout south India in different forms.

Table 1: Plant Sources Used By Different Tribes of South India for Mosquito Repellency

Sl. No.	State	Tribes	Plant Sources	Family	Common Name	Form of Usage
1.	**Tamil Nadu** (Arulappan et.al (2015))	Siruvani hills	Cissampelos pareira L.,	Menispermaceae	Midwife's herb	Topical Application of Leaf Juice
			Ocimum canum Sims	Lamiaceae	Haory Basil	The whole plant is grown inside house
		Kalrayan Hill	Premna latifolia Roxb	Verbenaceae	Dusky fire brand bark	Dried stem soaked in the water are used as mosquito repellant
			Azadirachta indica A.Juss.	Meliaceae	Neem	Burned fumes from the leaves
	Mustapha et.al (2015)	Irulars tribes from Siruvani hills- nilgiri mountains	Aloe vera (L) Burm.f	Liliaceae	Aloe vera	Juice extracted from plant is sprayed in houses
			Anisomeles indica (L.) Kuntze.	Lamiaceae	Catmint	The dried leaves are powdered and sprayed as sambrani (emits fragrant fumes when burnt)
			Azadirachta indica A.Juss.	Meliaceae	Neem	The leaves are burnt and the fumes act as a repellent against insects and mosquito
			Helicteres isora L.	Malvaceae	Indian Screw Tree	Topicalapplication of Juice extracted from plant parts
			Ocimim tenuiflorum L	Lamiaceae	Holy basil/Tulsi	Topical Application of essential oils and Juice extracted from leaves applied to skin.
	Senthil et.al (2015)	Kalrayan hill, Eastern Ghats of Tamilnadu	Premna latifolia Roxb	Verbenaceae	Dusky fire brand bark	Dried stem soaked in the water are used as mosquito repellant
	Karthik et.al (2014)	Paliyar Tribes of Sembarankulam, Dindigul District	Azadirachta indica A.Juss.	Meliaceae	Neem	Burnt Fumes of Dried leaves
			Ficus Hispida L.	Moraceae (Mulberry family)	Hairy Fig	Placement of crushed fruits near mosquito affected area acts as mosquito repellent.
	Vijayalakshmi et.al (2011)	Cuddalore district, Tamilnadu	Azadirachta indica A.Juss.	Meliaceae	Neem	Burnt Fumes of Dried leaves
	Subramanyam et.al (2009)	Irulas tribe in the Kodiakkarai Reserve Forest	Azadirachta indica A. Juss	Meliaceae	Neem	Burnt Fumes of Dried leaves with charcoal.
			Vitex negundo L.	Verbenaceae	Chaste Tree	Topical application of leaf extracts
	Ayyanar et.al (2005)	Kani tribals in Kouthalai of Tirunelveli hills	Cipadessa baccifera Miq + Vitex negundo	Meliaceae+ Verbenaceae	Maramalli+ Chaste Tree	Topical Application of juice extracted with mixture of these two leaves.
2.	**Kerala** (Khan et.al (2016))	Attappadi	Cymbopogon Citratus (L.)	Poaceae	Lemon Grass	Application of Leaf extracts on

						external body parts
			Murraya koenigii	Rutaceace	Curry leaf	Topical application of essential oils extracted from leaves
			Ricinus communis (L.)	Euphorbiaceae	Castor bean plant	Fumes of leaves when burned along with charcoal acts as mosquito repellent
	(Haridas et.al (2015))	Kattunayakans	Pandanus odoratissimus L.f.	Arecaceae	Kewda	Crushed inflorescences are mixed with water and sprayed over mosquito affected areas
			Pongamia pinnata (L.) Pierre	Fabaceae	Indian Beech	Crushed leaves and barks are mixed with water and sprayed over mosquito affected areas.
	Jose et.al (2015)	Paniayas tribe of wayanad district	Leucas Zeylanica	Lamiaceae	Thumba	Topical application of essential oil derived from whole plant
	Limcy et.al (2013)	Attappady and Vakkodan Hill region- Jellippara, Agaly, Kottathara and Kookampalayam	Butea monosperma	Fabaceae	Flame of the forest	Gum like juice from its flower kills mosquito
3.	**Karnataka** ((Venkatachalapathi et.al (2016))	Irula tribes	Canarium strictum added with Allium sativum and Curcuma aromatic.	Burseraceae+Alliaceae + Zingiberaceae	Black Dammar+ Garlic+Wild Turmeric	Infusion of all the three in powder form and using them as Topical application
			Canarium strictum Roxb.	Burseraceae	Black Dammar	Topical application of Bark Powder
			Melia dubia added with Allium sativum, Canarium strictum and Curcuma aromatic.	Meliaceae + Alliaceae+ Burseraceae+ Zingiberaceae	Malabar Neem+Garlic + Black Dammar+Wild Turmeric	Topical application of mixture of four powders
			Melia dubia L.	Meliaceae	Malabar Neem	Topical application of Bark Powder
	(Prakasha et.al (2006))	Sringeri taluk (Kavadi, Kuthugodu, Nemmaru, Kigga and Hulugaru)	Adhatoda vasica Nees.	Acanthaceae	Malabar nut	The plant is burnt and the fumes are used as mosquito and pest repellents.
			Vitexnegundo Linn	Verbenaceae	Chaste Tree	Topical application of leaf Extracts
	Natarajan et.al (2003)	Bidar, Gulbarga, Raichur, Yadgir	Vitexneugundo Linn	Verbenaceae	Chaste Tree	Topical application of fruit pulp
	Kshirsagar et.al (2001)	Mysore and Coor districts- Tribes namely- jenukuruba bettakuruba. Soliga, yerava, Panjariyerava, malekudia, Tammadi medha, hakki-pikki,	Aloe Vera (L) Burm f.	Liliaceae	Aloe Vera	Growing of plant in and around house
			Pongamia pinnata (L) Pierre	Fabaceae	Indian beech	Seed oil is mixed with kerosene to light up the lamps

		paniyerava gowdakuruba, kadu-kuruba, kaniyan and girijana				
4.	**Andhra Pradesh and Telangana** (Parijatam et.al ((2016))	Jatapus, Kondadoras, Mukadoras, Mannedoras, Yerukulas, Goudus, Gadabas and Savara.	Acacia nilotica (Linn.) Willd	Mimosaceae	Gum Arabic	Essential oil extracted from stem bark is applied on external body parts to repel mosquitoes
			Cassia alata Linn.	Caesalpinaceae	Candle Bush	Dried and fresh leaves are burned and the fumes acts as mosquito repellent.
			Cymbopogon flexuosus (Linn.) Rendie.	Poaceae	Malabar Grass	Oil acts as an excellent repellent against mosquitoes for hours.
			Pongamia pinnata (Linn.) Pierre	Leguminoseae	Indian beech	Seed oil applied on external parts of body
	Rajgopal et.al (2015)	Lankamalleswara wildlife sanctuary, Kadapa District	Chloroxylon swietenia DC	Flindersiaceae	East India Satin Wood	Stem bark paste made into bolls and used as mosquito repellent
			Tinospora cordifolia (Willd.) Miers	Menispermaceae	Heart- leaved moon seed	Leaf paste made into bolls and used as Mosquito repellent
	(Saidulu et.al (2015))	Pocharam wildlife Sanctuary, Telangana	Chloroxylon swietenia	Rutaceae	East India Satin wood	Fumigants of the fresh/dried wood/leaf acts as mosquito repellen
			Hyptis suaveolens	Lamiaceae	American Mint	The dried plant parts are burned and the fumes acts as mosquito repellents
			Ocimum americanum	Lamiaceae	Spice Basil	The juice extracted gives a sweet scent of camphor which when applied on body helps in repelling mosquitoes
	Bharath Kumar et.al (2014)	Tribals of Sriharikota Island, Andhra Pradesh- Penubakam, Kothachenu and Chengalpalem	Eugenia bracteata (Willd.) DC	Myrtaceae	Shining Bracteata	Fresh leaves taken and burnt. The smoke acts as mosquito repellent.
	Reddy et.al (2014)	Medak district, Andhra Pradesh-	Pentanema indicum (Linn.) Ling	Asteraceae	Sonkadi	Leaf juice used as a lotion to repel mosquitoes.
			Premna latifolia Roxb.	Verbenaceae	Dusky Fire Brand Bar	The twigs are burnt and fumes spread out in the home/ dried stem soaked in the water
	Padal et.al (2013)	Arakuvalley Mandalam, Visakhapatnam District	Chloroxylon swietenia DC	Flindersiaceae	Ceylon satin wood	Stem bark paste made into bolls and used as mosquito repellent
			Cymbopogon flexuosus (Linn.) Rendle.	Poaceae	Lemon grasss	Leaf juice is sprayed around the surroundings

						of the house for mosquito repellent
	Ravi Prasad et.al (2011)	Rudrakod Sacred Grove in Nallamalais-Chenchu Tribes	Chloroxylon swietenia DC	Rutaceae	Ceylon satin wood	The smoke of burnt leave is used as mosquito repellent.
	Pratap et.al (2009)	Kailasagiri forest range of Chittoor district	Anisomeles malabarica (L.)	Lamiaceae	Malabar Catmint	Small branches are hung over at entrance door to drive out the mosquitoes.
			Bixa orellana L.	Bixaceae	Annatto	External application of seed pulp is indicated as mosquito repellant.
			Leucas aspera (Willd.) Link	Lamiaceae	Common Leucas	Small branches are used as festoons to drive out the mosquitoes
5.	**Orissa** (Pattanayak et.al (July 2015))	Santal, Kolha, Munda, Saora, Shabar and Bhottada, Bhumij, Bhuiya, Oraon, Paroja and Kisan	Ageratum conyzoides L.	Asteraceae	Billy goat weed	Dry Leaves+cowdung
			Annona squamosa L	Annonaceae	Custard apple	Dry Leaves
			Barleria prionitis L.	Acanthaceae	Porcupine flower	Dry Leaves+ coir pith
			Cellastrus paniculata Willd	Celastraceae	Intellect tree, Black oil plant	Seed oil
			Eucalyptus citriodora Hook	Myrtaceae	Lemon eucalyptus	Dryleaves + cowdung
			Lantana camara L	Verbenaceae	Lantana	Dry leaves+ cowdung
			Trychnos nux vomica L	Strychnaceae	Poison Nut	Seed oil
	Panda et.al (2011)	Mayurbhanj district, Orissa	Celastrus paniculatus Wild	Celastraceae	Black seed oil plant	Oil from seeds is used as mosquito repellent, leeches and other biting insects.
			Cymbopogon martini (Roxb.)	Poaceae	Ginger Grass	The Leaves are crushed and the juice extracted is applied externally on exposed body parts.
	Sahu et.al (2013)	Boudh district of Odhisha	Diospyros melanoxylon Roxb	Ebenaceae	Black Ebony	Oil from seeds is used as mosquito repellent, leeches and other biting insects.
6.	**Goa** (Satyawam Naik, et.al (2014)	Kunabi, Velip, Gawde, Chambhar, mhar, kansar	Adhatoda Vasica	Acanthaceae	Malabar nut	Fumigants from burned bark, leaves and root acts as Mosquito repellent
			Cassia fistula, linn	Leguminosae	Golden shower	Application of leaf extracts on the external body parts.
			Eucalyptis globules, labill	Myrtaceae	Blue Gum Tree	Application of leaf extracts on the external body parts.

CONCLUSIONS

The plant sources, which were found to be used as mosquito repellents by tribes are *Cymbopogon flexuosus, Ocimum americanum, Tinospora cordifolia* (Willd.), Miers *Pentanema indicum* (Linn.), Ling *Bixa Orellana* L, *eucalyptus globules, Cassia fistula.* These were used as topical application of leaf juice (or) essential oils extracted from leaves and plant parts. Whereas, *Adhatoda Vasica Euphorbia Milli* Des. *Azardiracta Indica* A. Juss, *Dalbergia sissoo* DC, *Vitex negundo* Linn, *Artimesia vulgaris* L, *Clausena anisata, Adhatoda Vasica Anacardium Occidentale* are used in the burnt form, i.e., fumigants from the burnt plant parts are used as mosquito repellents.

It is observed from this review conducted that burning of dried leaves from *Azadirachta indica* A.Juss, *Vitex negundo* L, various species of *Ocimum, Adhatoda Vasica, Pongamia pinnata (Linn.)* pierre, topical application of *Aloe Vera* (L) Burm f., *Vitex negundo* L., *Ocimim tenuiflorum* L., *Ocimum canum* Sims, *Ocimum* gratissimum Linn, *Eucalyptis globules,* labill and *Lantana Camara* in juice form or as essential oils extracted from leaves/plants, and planting of *Azadirachta indica* A.Juss and *Ocimum sanctum* L in and around the houses are the major ethno botanical sources to repel mosquitoes.

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